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Challenges and Benefits of Digital Workflow Implementation in Aerospace Manufacturing Engineering

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Abstract

Companies who operate in highly regulated industries have further challenges to the usual competition, continuous cost reduction and product development challenges. To address these requirements companies optimise their business processes and change their applications and information systems to support their evolving way of doing business.
Workflow management technology eases the achievement of these necessities by providing methodologies, software and tools to support business process modelling, reengineering and workflow automation. Business process mapping is necessary in order to capture business processes as workflow specifications. Then, these systems allow business process reengineering, helping the optimisation of specified processes, and workflow automation, in order to generate a lean digital workflow from the specifications.
There are many opportunities to benefit from this technology in aerospace applications, however these bring several implementation challenges in large global companies operating in multiple markets and need to be carefully managed.
This research provides an overview of the benefits that digital workflows implementation can potentially bring to aerospace companies, together with a detailed description of significant challenges, regarding both the implementation of digital workflows and risks related to human factors. The study increases industry awareness on the importance of driving a digital transformation through implementing digital workflows, and where to start this implementation in a manufacturing business, highlighting the success factors.

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Keywords: Digital workflows, Workflow management, Business process optimisations, Digitisation, Complexity management

1. Introduction

Industries with technologically complex products and highly regulated environments such as aerospace, nuclear and defence, have several requirements that drive complexity to the way they do business [1]. Additionally, these companies have a wide set of tools and systems, and their supply chain and organisational structures are intricate. All this gets reflected in these organisations business processes and management systems, which are very comprehensive to be able to manage the many requirements. Large manufacturing companies require a higher cross organisational collaboration, leaner digitised processes and increased visibility and interaction between management layers and production, while continuing to meet customer requirements.

Effectively managing this complexity is a key objective for aerospace manufacturing organisations, and management are looking for solutions to simplify their business processes, with Workflow Management Systems being one of the preferred options. In similar industries, such as marine engines manufacturers or power systems, companies have realised great benefits [2] after implementing workflow solutions.

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1.1Workflow Management Systems

Workflow Management Systems (WfMSs) are software systems that help support collaboration and coordination among company members, assisting them in the completion of complex business processes [3].

WfMSs support the operation of digital workflows, which describe business processes in a way that allows a certain degree of automation and focus on automating parts of the process. They represent the business process as a sequence of activities, with tasks that can be either fully automated (hence executed exclusively by a computer) or assigned to employees, who might carry out the task supported by a computer.

The workflow system controls and tracks the progress of processes by pulling and supporting all the activities, and after completion of each task, it checks that it has been correctly performed. Therefore, these management systems help the achievement of the business goals with greater efficiency [3].

Nomenclature

WfMS	Workflow Management System
LDW	Lean Digital Workflows

Also, workflow management systems usually allow the creation of key metrics, helping to measure and analyse the efficiency of the business process, facilitating the practice of continuous improvement.

In addition, these systems are often integrated with other company tools and systems, such as e-mail, databases, project planner, communication tools, etc. Integrating these capabilities gives structure to the business processes, which usually employ several different independent systems [4].

Manufacturing companies require a high level of flexibility, scalability, reliability and interoperability coming from their management systems, and digital workflows can help efficiently meet these requirements. Figure 1 shows how digital workflows, with a goal to automate tasks and integrate tools, are linked to business processes, which are at a higher level, as a business process can comprise several workflows.

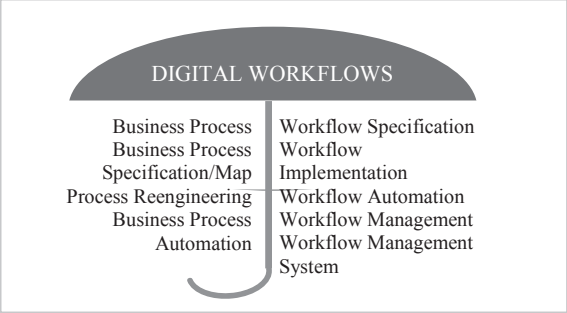

Figure 1: The workflow umbrella. Source: [5]

The next chapter outlines the major benefits of digital workflows for large companies, and highlights the challenges that are present during the implementation process and system service.

2. Benefits for aerospace companies

Introducing digital workflows and workflow management tools is an opportunity to improve, automate and streamline the underlying processes in a business.

Since workflow management systems demand examination and definition of a manufacturing company's business processes, it is a convenient time to optimise these processes. In fact, it is vital to conduct an analysis of the underlying process and improve it where necessary, prior to digitising the process, so the organisation can avoid embedding bad practices on the system [6].

Aerospace organisations can realise several benefits by implementing appropriate digital workflows. Some of these benefits come from the workflow automation while others from the process mapping and business process optimisation that has to be carried out prior to workflow automation. This review highlights the most relevant benefits, which have been collected from one to one interviews, industry workshops, literature review and digital transformation themed conferences. The outcome is gathered in the following list:

- Improved efficiency

Automation of parts of the business process helps in reducing the number of unnecessary steps within a workflow, thus improving the overall efficiency of the process. A properly implemented digital workflow does the same job as an employee, but faster and without human errors, which leads also to lower operational costs.

- Improved accountability and visibility

Digital workflow solutions are very helpful for management. Most WfMSs include a tool that helps visual tracking of the workflow status, as well as role assignment for each task. The system clearly shows which tasks are required, the employee responsible for its completion and when the task should be completed.

Managers are capable of understanding who is accountable for each action. Additionally, accountability and employee approval hierarchy are clearly stated, promoting improved transparency. These workflows solutions usually assign the task to a role, as shown in Figure 2.

Figure 2: Role assignment in workflow automation. Source: [7]

- Reduced number of errors

Having the right workflow system will remove many human errors, saving time and resources by reducing the need for additional checks. The system is additionally able to notify late actions and overlooked tasks among others.

- Streamlined Processes

A workflow management system provides a better insight of all the steps that go into a business process. This helps its improvement, as it is for instance easier to notice which tasks can be completed simultaneously or which approvals are redundant.

Additionally, digital workflows allow data to be pulled from an upstream process or task, to use it as input for another activity located downstream. In aerospace manufacturing companies, several forms and documents created during the design phase are used in manufacturing as input, manually copying this data, which creates waste and the opportunity for errors which require additional checks to mitigate. Digital workflows inherently solve this, automatically populating downstream forms.

- Superior control, scalability and increased flexibility

Automating the workflow helps the enablement of standards regarding working methodologies and gives managers a better line of sight for audit trails and improved control. Additionally, processes that have been automated are easier to scale up as per business requirements. A right workflow management system helps the company to detect and therefore eliminate bottlenecks and meet new demands.

- Improved communication

Employees do not need to continue manually notifying their managers or other team members when a task or process has been completed. Process status tracking and notifications keep all employees informed, as managers are able to program the software so it notifies employees whether a deadline is approaching or if they have actually missed it. In addition, team leaders can be sure that all employees involved in a project are aware of changes in scheduling, new requirements or guideline updates. This enhanced communication helps the company to move on to new projects consistently.

- Employee Motivation

Reducing the number of manual and repetitive tasks through automation motivates employees as they can focus on more challenging activities, boosting continuous improvement and morale.

- Integration and real time reporting

A digital workflow, with the right platform, is able to integrate other company tools or systems, such as legacy databases, ERP systems, and other IT tools that the organisation might be using. In this way, all disseminated data and systems play their pertinent roles in one process, and related documents can be integrated. Also, real-time reporting and process tracking available to management improves decision making, and checklists can be integrated increasing visibility in each decision point along processes.

If the WfMS is implemented as part of an extended business solution, considerable additional benefits can be achieved, such as improving the existing organisational structure. Workflow systems can help manufacturing companies achieve changes regarding the organisational structure in order to operate more effectively, having a more agile structure. For instance, an integrated workflow system could eventually lead to a greater team orientation and a flatter organisational structure. As rules, activity steps and roles are built into the system, management needs less intervention to control the business process.

Additionally, the improved communication –through automatic notifications, scheduling and document sharing- usually leads to greater collaboration among team members, or even business units. If the WfMS is integrated with an email application for instance, notifications can be easily sent through it, and also platform pop-ups and text messages are able to replace other manual means.

These benefits are realised through different workflow management tools and features that might operate at different business levels, some of them affect the business process sequence itself and some others work on a task level, for instance guiding the employee in the completion of a task or assigning roles. Table 2.1 summarises the benefits that workflow management software could bring to the aerospace industry, and how those can be realised.

Table 1: Benefits of WfMS in the aerospace industry and means of realisation

Benefit	Mean of Realisation
Improved Efficiency	Workflow Automation
Improved Accountability and Visibility	Workflow status tracking tool & Role assignment tool
Document Right-First-Time	Error-proofed, pre-filled forms
Streamlined Processes	Workflow progress tracking tool
Superior Control, Scalability and Flexibility	Workflow Management Software
Improved Communication	Automatic Notifications
Employee Motivation	Workflow Automation
Integration and Real Time Reporting	Tool and databases integration

Workflow automation embeds the business intelligence coming from experience into the system [8], and information and practices that might have been scattered among a few experienced employees is made available on the system and visible to all organisation members. This benefits less experienced employees who have a limited understanding of the business processes. Having a workflow management system increases the knowledge and flexibility of the workforce in a company.

For a specific project or particular job, the workflow system provides more information about historical data in an

organised way and makes it available to all employees with access to that project.

In terms of security and reliability, a workflow management system could provide aerospace companies a more efficient way to secure access to all data. This can be achieved by using mechanisms like role based access, which determines who can access the information and who can modify it. It also supports process control, who has to approve a document before moving on to the next task, system back-ups and version control. This helps the creation and maintenance of reliable and accurate data.

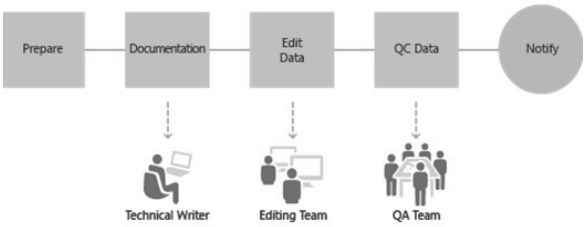

Figure 3: Example of a simple workflow and role assigned per task. Source: ArcGIS Pro vendor website.

Some of these benefits can be realised in the short-term, which is the case of workflow progress tracking and better balance of workload, or long-term, through tools integration, bottlenecks detection, which are detected thanks to greater visibility, and activities sequence to seize concurrent opportunities and leaner processes.

3. Challenges

The benefits of workflow management systems appear significant for large companies, but there are several challenges that need to be taken into account, as these systems usually drive a transformation in the company and the aerospace sector has characteristics that create some special challenges in realising this transformation.

Investing in workflow management tools will not solve problems related to the underlying business process, the digitisation of the process would automate existing practices, which is the main reason why the process should be mapped and optimised prior to its automation.

Therefore there are several issues that need consideration before implementing any workflow management system, including the following:

- Defining complex processes

The combination of industry requirements, product complexity and business scale can make it difficult to reengineer business processes. Normally, overcoming this issue and being able to map the process heavily depends on employees' commitment. In order to ensure success, it needs to be considered that a significant amount of time is usually needed to be allocated to this stage. Detailed understanding of the underlying business process and requirements capture is required in order to develop a reliable workflow definition.

- Worker resistance

In most cases, human factor issues are the main obstacle to the acceptance of workflow applications [8]. Employees may see workflow management as a way of reducing their decision-making power, as management has a greater visibility of the process and can make decisions that used to be made by workers. Other employees might feel put off by being monitored and could feel that the WfMS is invading their privacy. These issues need to be closely managed and balanced against the benefits WfMS bring such as a reduction in repetitive tasks.

- Management engagement

Managers must play a central role in setting up priorities and objectives. They should get involved in the decision making process and be informed of every step in the implementation plan.

Engaging the right managers in the project will help to attribute roles and responsibilities to different stakeholders, so that the implementation is successful and so that no conflicts arise between the stakeholders.

Not involving the stakeholders during the early phase of planning hinders the collection of quality data, and leads to a lack of perspective of what is considered a credible, high quality and attainable project within the organisation. Involving the right people from the beginning contributes to the development of a realistic project scope definition and consistent program logic.

- Overmanagement and creation of new work

When describing a workflow process, it can be defined at different levels of detail. A system which tries to monitor and guide through every detail of the process might be excessive, incurring unnecessary costs as well as worker resistance. Also, managing the business and technical aspects of the system will create additional work [9].

- Loss of flexibility:

Some business processes and tasks require employees to use personal judgment and remain adaptable. These are generally not good candidates for workflow automation. Aerospace companies need to dedicate time to choosing the right processes to be digitised.

Processes which will benefit most from digital workflows are those that will advantage from a defined and monitored process as well as profit from the integration of that process across different company tools and systems. Good candidates are processes which are document intensive, include lots of hand-offs among end users, and require high collaboration [10].

Nevertheless, other processes with less documentation required can also benefit from digital workflows if they are implemented with a flexible and simple workflow management system.

It is crucial that companies follow consistent criterion within their organisation for selecting the processes to be digitised, in order to be able to justify their election. Typical criteria for spotting processes that might benefit from digitisation include speed, as prolonged processes are often the first to get attention when looking at workflow solutions, and cost. Costs to be aware of include frequent routing of simple tasks to high-skilled workers and higher labor costs. But each company has to define its own criteria, in alignment with its strategy.

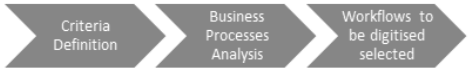

Figure 4: Selecting business processes for digital workflow implementation

Once business processes for digital workflow implementation are identified, priority can be given to those solutions which will have a higher impact on the organisation.

- Technical implementation costs

WfMSs can be expensive, requiring a variety of resources to manage. Cost considerations include the purchase price of the workflow system software, application and IT tools development and implementation, customisation of the product, and the need of specialist skills in order to optimise the process.

Once the decision has been made, several challenges arise regarding the implementation of digital workflows.

Firstly, manufacturing companies need to thoroughly consider change control within the workflow. Typical concerns are how to modify the workflow in terms of coming back to past points, creation of stop points within the workflow, definition of concurrent parts, freezing of a workflow fragment while waiting for a concurrent part to be finished, etc.

Also, as these organisations usually complete several iterations during a process, there is a need to do this in a highly synchronised way. Large companies achieve their processes' outputs after several iterations. Some of these iterations are within a workflow step, which is simpler to support in a workflow configuration, but some other iterations involve several workflow steps. There is a need of a workflow management system that supports these iterations in a simple, configurable way.

Another concern for the aerospace industry is how to integrate all the tools, databases and systems used. The workflow system has to be capable of integrating all these capabilities. Without proper integration, it would be difficult to realise most benefits.

In specific cases it is crucial that the system allows making conditional go-aheads. Aerospace companies require flexibility in terms of being able to continue with the process even if some of the milestones have not been achieved. The workflow system allows greater visibility, so the decision maker knows the risks of continuing with the process. It is important that the digital workflow incorporates this characteristic, so trade-off decisions can be made, as these solutions often happen in large complex companies.

4. Success Factors

Digital workflow projects are usually launched to improve organisational performance. The earlier phases of a workflow project are commonly more critical to the overall success of the project [11]. As stated by [12], there are a number of recommended practices for implementing a successful workflow management system in an aerospace company. Among these recommended practices are the following success factors:

- Obtain support of senior management: it is important that management support is visible and available at the long term, and not just for project approval. Having a quantifiable business justification is highly persuasive in getting upper management support.

- Integrate the digital workflow with current systems: many of the advantages of digital workflows are the result of its integration with existing IT tools and systems already being used in the process. The purpose of digital workflows is to integrate these systems, adding integrity to the process. Additionally, a significant number of goals of workflow reengineering can only be achieved as a result of systems and new tools being implemented along with the workflow system. These might include workflow progress trackers or document management systems.

- Get the support of end users: stakeholders must be involved in all phases of implementation. This includes the process definition, optimisation and automation. Stakeholders have to be aware that the digital workflow implementation will fail without their commitment. End users need to understand that the workflow system will automate day to day tasks in order to free up part of their time for more productive work and they should also know that they will receive adequate training and will be provided enough time to learn the workflow system before benefits are expected to be realised.

- Implement in phases: conducting a digital transformation in all business units and processes at the same time is challenging and costly, as there is a massive number of factors that influence this implementation, and a proper deployment usually implies several iterations. It is recommended to start with just a few users and a limited number of activities, and then expand the project in order to reach the defined scope. The company needs to seek a scalable solution, so it can start small but then be capable of growing using the chosen technical solution.

-Focus first on processes that are fully understood: for initial implementations, projects with clearly understood activities and tasks should be chosen.

- Use metrics: it is useful to take baseline measurements so that expected benefits can be quantified. Once the digital workflow is implemented, these metrics can be tracked in order to spot positive or adverse trends. It is important to ascertain expected benefits before undertaking a workflow system project, as many apparently successful programmes can experience difficulty justifying their contribution to the company performance due to a lack of pre-determined benchmarks for outcomes.

5. Conclusions

Digital workflows are a suitable solution for managing business processes complexity in the aerospace industry, but companies within this sector need to be aware of all challenges that are associated with implementing a workflow system .

Aerospace companies are attracted by the numerous benefits this technology can bring, and are keen on launching digital transformation programmes. However implementing a workflow management system requires solid management engagement, end user involvement, tools and system integration and a sensible implementation plan.

This research raises awareness of all recommended practices for the aerospace industry and issues that might emerge, helping these organisations for a better implementation.

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